HP Turbine Dens
Operating Options and Econ

		Unit Operation			Economics		
Option	Description	Station Max Gross Load	Station Net Heat Rate (BTU/KWH)	Station Fuel Consumption (Tons/Year)	Total Capital Cost	Benefit Per Year	Pa Perio
	Current Operation	1750 MW	9500	5,268,249	NA	NA	
1	Maintain the same historical maximum load with improved heat rate.	Same	-214	-118,536	$9,400,000	$4,267,282	
2	Maintain the same historical steam flow and increase turbine/generator output. (Note 6)	40 MW	-214	Same	$9,600,000	$15,137,280	
3	Install additional plant improvements to increase boiler and other systems capacity. Install moderate NOx reduction equipment (Note 7).	100 MW	-214	310,224	$36,400,000	$35,784,705	

Item	General Assumptions	
1	Present Value Annuity Factor (P/A, 6.35 %, 20 years):	11.2
2	Hours of equivalent operation/year (8760X 0.9 Cap. Factor):	7884
3	Cost of Fuel ($/Ton):	$36
4	Cost of replacement energy ($/MWH)	$48
5	Avoided maintenance cost for the station (Note 1):	$5,304,000
6	High pressure turbine section retrofit:	$9,400,000
7	Cost of additional plant improvements (Note 2):	$12,000,000
8	Cost of moderate NOx control equipment (SNCR):	$15,000,000
9	Operating cost per year for SNCR (Note 4):	$2,058,495
10	Coal (BTU/LB)	11,800
11	Urea (SNCR Reagent) Utilization per Ton NOx removed (Tons)	1
12	Cost of Urea per Ton (Note 3)	$300

Analysis for Option 1	
Turbine Efficiency Increase (guaranteed by supplier) =	2.25%
Boiler Heat Input Reduction = Proportional to Turbine Efficiency Increase =	2.25%
Net Heat Rate Reduction = 2.25%(9500 BTU/KWH) =BTU/KWH	214
Reduced Fuel = (Heat Rate Reduction)(Station Net Load)(Equiv.Hrs)/(Coal BTU/Lb)(2000 Lbs/Ton) = (Tons)	118,536
Benefit per Year = (Reduced Fuel)(Cost of Fuel) = $	$4,267,282
Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.96
Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs - Avoided Costs) =	11.67

5/1/2002

HP Turbine Dense Pack Modifications
Operating Options and Economic and Environmental Analysis

Unit Operation			Economics				Environmen		
tion Max oss Load	Station Net Heat Rate (BTU/KWH)	Station Fuel Consumption (Tons/Year)	Total Capital Cost	Benefit Per Year	Payback Period (Years)	Benefit/Cost Ratio	NOx Emissions per Year (Tons)	SO2 Emissions per Year (Tons)	En
750 MW	9500	5,268,249	NA	NA	NA	NA	26109	2984	Current E lbs/MBTU SO2. Bc basis.
Same	-214	-118,536	$9,400,000	$4,267,282	0.96	11.67	-587	-67	Operatin trigger a Preventic (PSD) re year wou
40 MW	-214	Same	$9,600,000	$15,137,280	0.28	39.46	Same	Same	Since the not chan mandate difficult t year natu
100 MW	-214	310,224	$36,400,000	$35,784,705	0.87	12.89	-6362	-680	Permittin not be dif 0.46 LBS more agg not be ma

	Analysis for Option 1		Analysis for Option 2		
11.2	Turbine Efficiency Increase (guaranteed by supplier) =	2.25%	Benefit per Year = (Increased Generation)(Equiv. Hrs.) (Cost of Replacement Energy) = $	$15,137,280	Note 1 - section
7884	Boiler Heat Input Reduction = Proportional to Turbine Efficiency Increase =	2.25%	Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.28	
$36	Net Heat Rate Reduction = 2.25%(9500 BTU/KWH) =BTU/KWH	214	Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs - Avoided Costs) =	39.46	Note 2 - capacity towers,
$48	Reduced Fuel = (Heat Rate Reduction)(Station Net Load)(Equiv.Hrs)/(Coal BTU/Lb)(2000 Lbs/Ton) = (Tons)	118,536			
$5,304,000			Analysis for Option 3		Note 3 -
$9,400,000	Benefit per Year = (Reduced Fuel)(Cost of Fuel) = $	$4,267,282	Benefit per Year = (Increased Generation)(Equiv. Hrs.) (Cost of Replacement Energy) - Operating Cost/Year = $	$35,784,705	
$12,000,000	Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.96			Note 4 -
$15,000,000	Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs - Avoided Costs) =	11.67	Payback Period = (Capital Costs - Avoided Costs) /Benefit per Year = Years	0.87	
$2,058,495			Benefit to Cost Ratio = (Benefit per Year)(PV Annuity Factor)/(Capital Costs-Avoided Costs) =	12.89	Note 5 - removal walls th
11,800			Increased Fuel = (Decreased Heat Rate)(Increased Net Load)(Equiv.Hrs)/(Coal BTU/Lb)(2000 Lbs/Ton) = (Tons)	310,224	
1					Note 6 - and iso
$300					
					Note 7 Selecti such as

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: and Environmental Analysis

		Environmental			
k ears)	Benefit/Cost Ratio	NOx Emissions per Year (Tons)	SO2 Emissions per Year (Tons)	Environmental Assessment	Comments
	NA	26109	2984	Current Emissions limits are 0.5 lbs/MBTU of NOx and 0.15 Lbs/MBTU of SO2. Both on rolling 30 day average basis.	Current NOx emissions rate is 0.42 lbs/MBTU and SO2 is 0.048 lbs/MBTU
0.96	11.67	⇩ -587	⇩ -67	Operating in this manner should not trigger a New Source Review (NSR) or Prevention of Significant Deterioration (PSD) review. Variations from year to year would have to be explained.	There should be no change in NOx and SO2 emissions rate. Total tons per year reductions are from decreased coal burn.
0.28	39.46	⇔ Same	⇔ Same	Since the NOx and SO2 emissions should not change, increasing load should not mandate a NSR or PSD review. May be difficult to prove as it varies from year to year naturally.	There should be no change in NOx and SO2 emissions rate.
0.87	12.89	⇩ -6362	⇩ -680	Permitting with moderate NOx control should not be difficult. Current laws would require 0.46 LBS/MBTU limit in the future. Plans for more aggressive reduction (IE: SCR's) should not be made at this time.	Assumes NOx emissions will decrease to 0.3 Lbs/MBTU and SO2 emissions will decrease to 0.035 Lbs/MBTU (See Note 5)

Analysis for Option 2	
Year = (Increased Generation)(Equiv. of Replacement Energy) = $	$15,137,280
riod = (Capital Costs - Avoided Costs) Year = Years	0.28
ost Ratio = (Benefit per Year)(PV tor)/(Capital Costs - Avoided Costs) =	39.46

Analysis for Option 3	
Year = (Increased Generation)(Equiv. of Replacement Energy) - Operating $	$35,784,705
riod = (Capital Costs - Avoided efit per Year = Years	0.87
ost Ratio = (Benefit per Year)(PV or)/(Capital Costs-Avoided Costs) =	12.89
uel = (Decreased Heat sed Net Load)(Equiv.Hrs)/(Coal 0 Lbs/Ton) = (Tons)	310,224

Notes

Note 1 - Avoided maintenance cost equals the normal overhaul cost for the turbine HP section plus the avoided outage extension of 3 days to refurbish the HP nozzle block.

Note 2 - Cost of additional plant improvements are the projects necessary to increase the capacity of all other plant systems to handle the increased load. This includes the cooling towers, main transformer, generator cooling and other systems.

Note 3 - Cost of Urea is based on $0.75 per gallon for a 50% liquid solution.

Note 4 - Operating cost for SNCR includes 1% of the capital cost per year for Maintenance.

Note 5 - SO2 emissions will decrease by installation of a device to increase scrubber removal efficiency. The device eliminates the "sneakage" of flue gas around the module walls thus improving removal efficiency.

Note 6 - Capital cost includes an extra $200,000 for minor modifications to main transformer and isophase duct to handle increased load.

Note 7 - For this economic analysis, moderate NOx reduction technology is assumed to be Selective Non-Catalytic Reduction (SNCR) because it is well proven. Other technologies such as ultra-low NOx burners will be evaluated before the final decision is made.